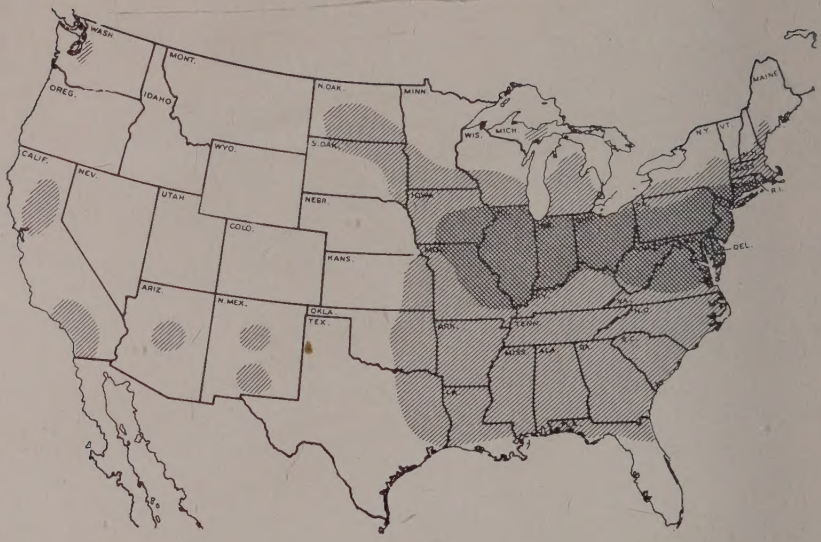
Bacterial Wilt and Stewarts Leaf Blight of Corn

Farmers' Bulletin No. 2092

U. S. DEPARTMENT OF AGRICULTURE

COMMONWEALTH AGRICULTURAL INSTITUTE
3 MAY 1956



Geographic distribution of bacterial wilt and Stewarts leaf blight of corn in the United States. Heavy shading indicates areas in which these diseases are more serious.

CONTENTS

	Page
Distribution of the diseases	1
Cause of the diseases	2
Symptoms of bacterial wilt	2
Symptoms of Stewarts leaf blight	6
Comparison of Stewarts leaf blight with other leaf blights of corn	7
Overwintering of the bacteria	7
Relation of disease development to winter temperatures	10
Spread of the diseases during the corn-growing season	10
Control of the diseases	11
Varietal resistance to bacterial wilt	11
Varietal resistance to Stewarts leaf blight	13

This bulletin supersedes Farmers' Bulletin 1878, Bacterial Wilt of Corn, by C. Elliott, from which much of this material was taken.

Washington, D. C. Issued October 1955

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 10 cents

Bacterial Wilt and Stewarts Leaf Blight of Corn

By Alice L. Robert, *Pathologist, Field Crops Reserch Branch, Agricultural Research Service*

Bacterial wilt is one of the oldest and best known diseases of corn. It is most severe on sweet corn, but this disease also attacks dent, flint, flour, and popcorn varieties. The bacterium that causes this disease [1] also produces a serious leaf blight on dent corn known as Stewarts leaf blight. The combined effects of bacterial wilt in sweet corn and Stewarts leaf blight in dent corn are of considerable importance to corn growers.

Formerly, bacterial wilt caused almost total losses of Golden Bantam sweet corn in certain areas. Canners who specialized in this early, yellow, high-quality variety soon turned to late-maturing resistant white varieties such as Country Gentleman and Stowell Evergreen. Resistant yellow hybrids have replaced these late white varieties in recent years. Golden Cross Bantam, released in 1933, was the first widely adopted resistant yellow hybrid. Since then many others have come on the market, including Aristogold Bantam Evergreen, Hoosier Gold, Ioana, Golden Harvest, and Marcross, which are adapted to various parts of the United States. The use of resistant sweet corn hybrids has now eliminated most of the losses from bacterial wilt.

In 1932 Stewarts leaf blight caused losses in dent corn, particularly in Indiana and Illinois. This leaf blight is now widespread. It attacks some of the new hybrids, thereby causing serious losses in dent corn in some years.

Distribution of the Diseases

Bacterial wilt was first found in sweet corn on Long Island in 1895, and now it occurs throughout the corn-growing areas of the United States (see map on inside of cover page). It has been reported from Canada, Costa Rica, Italy, Mexico, Puerto Rico, and the U. S. S. R.

The disease occurs to some extent each year in the United States from Long Island to Virginia, down into the Southern States, and westward through the Corn Belt. It was first generally noticed in the New England States and the Corn Belt. In these regions it caused the greatest losses to market gardeners, home gardeners, and canners.

The prevalence of bacterial wilt seems to decrease from south to north in the Corn Belt, and only in years when the disease was abundant throughout the Central States was it found very far north of the Corn Belt. About 1920 a careful search revealed no wilt in North Dakota, Minnesota, Wisconsin, Michigan, northern New York, Vermont, New Hampshire, and Maine, but in 1932 and 1933 the disease was found in all these States except Vermont. Every year since 1947 it has occurred to some extent on sweet corn in that State. It also has caused losses in southern Ontario

[1] *Bacterium stewartii.*

350203°—55

and has been reported from the Upper Peninsula of Michigan. Epidemics of bacterial wilt sometimes occur on the early susceptible sweet corns grown in these Northern States. Before World War II sweet corn was not grown extensively in the extreme Southern States, and the disease was found there only in scattered locations and was serious only in isolated fields. Sweet corn for market has expanded in the South; yet, losses due to this disease have remained low. Epidemics have been rare in all regions since resistant hybrids were adopted.

Stewarts leaf blight occurs in the same regions as bacterial wilt, since the same bacterium that causes bacterial wilt also causes Stewarts leaf blight. In the South it is found only in isolated fields. It occurs commonly throughout the Central and Northeastern States.

Bacterial wilt and Stewarts leaf blight of corn have been observed in 40 States. Losses from wilt in sweet corn in most of these States had become minor by 1954, most of the attacks being only sporadic and local. This may be attributed to the development and use of resistant hybrids. Resistant hybrids of sweet corn can be grown almost wilt-free in all corn areas. Stewarts leaf blight is seen more often among dent corn hybrids, especially in the Central States. In 1952 Stewarts leaf blight was heavier than usual in these States. Increasingly heavy attacks of Stewarts leaf blight also occurred in 1953 and 1954.

Cause of the Diseases

Bacterial wilt and Stewarts leaf blight are caused by a species of bacterium. Individual bacteria are microscopic, nonmotile rods less than one twelve-thousandths of an inch long. These bacteria get into the corn plants through wounds in the leaf tissue made chiefly by the feeding of corn flea beetles (fig. 1, *A*). Infected seed also may cause a young seedling to become affected with the bacteria. Once inside the leaf, the bacteria may multiply until they fill the water-conducting vessels of the veins of the leaf. This causes dead streaks in the leaf and sometimes large areas are killed, causing Stewarts leaf blight. If the bacteria spread through the leaf veins into the stalk and fill many of the water-conducting vessels in the vascular bundles, they prevent the plants from getting water and food materials and thus cause bacterial wilt. The bacteria may spread also through the stalk into the tassel and ear, and the infection may become general throughout the plant.

The symptoms of bacterial wilt found mostly on sweet corn are somewhat different from those of Stewarts leaf blight found mostly on dent corn.

Symptoms of Bacterial Wilt

Susceptible sweet corn varieties are subject to infection with bacterial wilt throughout their growth. Young infected plants in the field often wilt as if suffering from lack of water. The green leaves dry up one after another and the whole plant may wilt and die, even though there is plenty of moisture in the soil. Those that do not die become stunted, tassel prematurely, and produce no ears or, at most, only nubbins. Long, wilted, pale-green streaks with irregular or wavy margins develop in the leaf blades (figs. 2 and 3). These streaks may start from wounds made by flea beetles feeding on the leaves, usually on the tip half (fig. 1, *A* and *B*). The streaks may turn a pale yellow and die through the center and may spread along the veins into the stalk and dwarf or kill the entire plant. The vascular bundles,

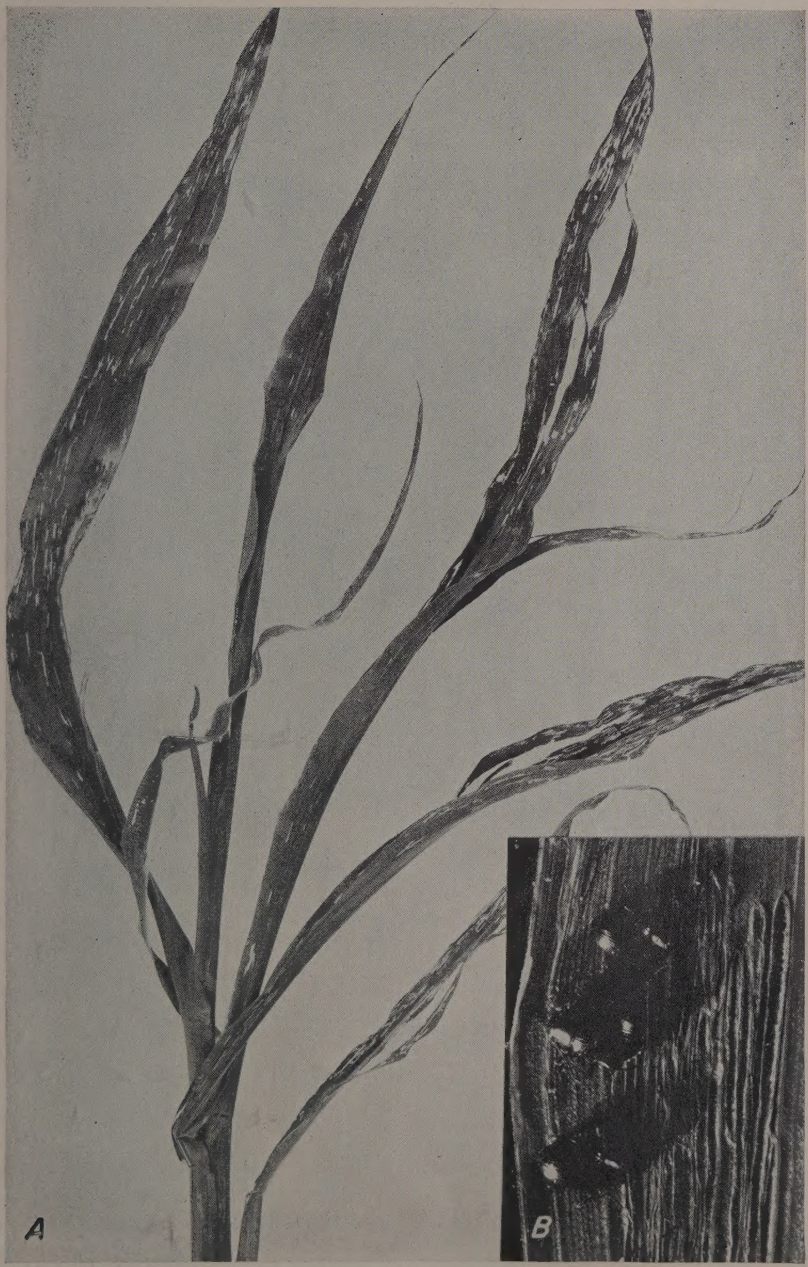


Figure 1.—Feeding injuries on leaves of corn plants caused by corn flea beetles: *A*, Plant from inbred line of yellow dent corn with feeding injuries but no bacterial wilt or Stewarts leaf blight; *B*, section of corn leaf showing flea beetles and conspicuous feeding channels (enlarged 8 times).

Figure 2.—Susceptible Golden Bantam sweet corn heavily infected with bacterial wilt, showing stunted plants, wilting of top, and long sreaks on leaves.

or water-conducting channels, of the stalks may become so filled with bacteria that when the stalks are cut crosswise masses of the bacteria ooze out as yellow, moist beads on the cut ends (fig. 4). Bacteria also may spread into the tissues along the vascular bundles of the stalks and form cavities in the pith.

Ears may become infected (fig. 5). Usually only part of the kernels are diseased, but all kernels of heavily infected ears may be damaged. Bacteria may spread through the shank and cob into the interior of the kernels. They also may come out in tiny drops on the inner surfaces of the husks and become smeared over the kernels. Small, irregular water-soaked spots on the inner and outer husks later become dried and darkened.

Young plants of dent corn are more resistant to bacterial wilt than are those of sweet corn. In spite of flea beetle feeding injuries, only a few young plants of dent corn become infected and very few develop bacterial wilt symptoms.

Figure 3.—Susceptible Golden Bantam sweet corn leaves, showing streaking of leaves caused by bacterial wilt.

Figure 4.—Cross section of a stalk of sweet corn infected with bacterial wilt, showing beads of bacterial ooze coming from the water-conducting channels in tiny droplets.

Symptoms of Stewarts Leaf Blight

On susceptible dent corn Stewarts leaf blight is recognized by the conspicuous streaks on the leaves (fig. 6). They generally appear on the leaves of susceptible plants when they are in tassel. At first they are light green to yellow and extend along the leaf veins with irregular or wavy margins. When they become older they turn tannish brown and dry. When the streaks are numerous they blend together and large areas of the leaf become involved. Sometimes entire leaves die and dry up. This premature firing or dying of leaves while the stalks remain green gives the plants the appearance of having suffered frost damage (fig. 7).

On resistant dent corn the streaks on the leaves are less abundant and considerably smaller. They often become only small oval spots 1 or 2 inches long. When infection is severe, more leaf area is destroyed and yield is reduced. The weakened

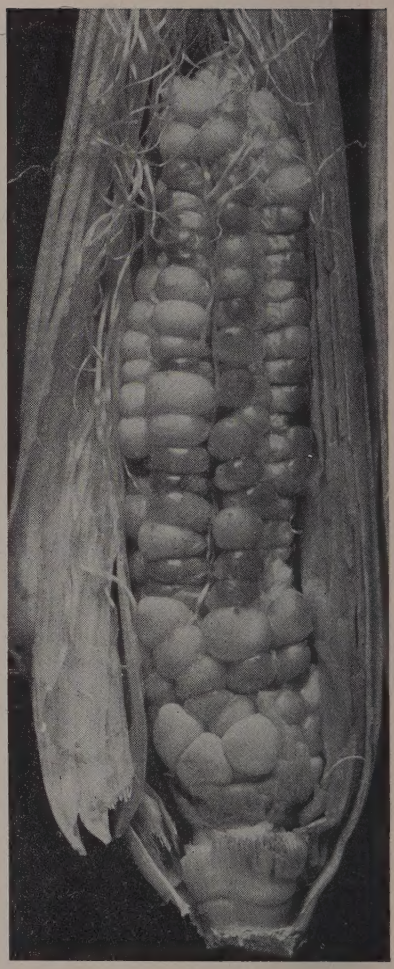


Figure 5.—Ear of sweet corn infected with bacterial wilt; part of the kernels are diseased.

plants become more susceptible to stalk rots.

The lower leaves usually are infected first, and the disease progresses upward. Rarely do infections in the leaves spread into the stalk and other parts of the plant. Stalks that are cut across, therefore, generally will not ooze yellow bacterial droplets. Ears of dent corn may become infected, but this is not common.

Figure 6.—Leaf of dent corn showing streaks of Stewarts leaf blight.

Some sweet corn hybrids will develop Stewarts leaf blight even if they are somewhat resistant earlier in the season to the bacterial wilt.

Comparison of Stewarts Leaf Blight With Other Leaf Blights of Corn

The symptoms of Stewarts leaf blight differ distinctly from those of another bacterial leaf blight on corn. In bacterial leaf blight [2] the stripes or spots on corn leaves are long and narrow with a reddish-brown margin. Badly streaked leaves shred readily, especially in rain or wind (fig. 8, *A*). Upper leaves may be attacked as readily as are the older lower leaves. Sometimes this disease is accompanied by a rot of the upper stalk.

The lesions of northern corn leaf blight [3] on corn leaves are large, spindle-shaped (or oval), grayish-green to tan spots (fig. 8, *B*). In severe attacks these spots blend together and much of the leaf area is killed. The disease is similar to Stewarts leaf blight in that it progresses from the lower leaves upward, attacks dent corn late in the season, and causes the leaves to become fired when attacks are heavy.

The lesions of southern corn leaf blight [4] and corn leaf spot [5] are small, well-defined, tan to brown spots (fig. 8, *C* and *D*). Both of these fungus diseases cause a firing of the leaves when the attacks are severe.

Streaks of Stewarts leaf blight may occur on corn leaves along with one or more of these diseases.

Overwintering of the Bacteria

The bacterial wilt and Stewarts leaf blight bacterium overwinters almost exclusively within the bodies of the corn flea beetle, and the beetle carries the bacterium to the young corn plants in the spring soon after the corn comes up. The adult beetles come out of hibernation as the weather becomes warm in April and May and begin to feed on growing vegetation including

[2] Caused by the bacterium *Pseudomonas alboprecipitans.*

[3] Caused by the fungus *Helminthosporium turcicum.*

[4] Caused by the fungus *Helminthosporium maydis.*

[5] Caused by the fungus *Helminthosporium carbonum.*

Figure 7.—Rows of dent corn showing the general appearance of firing of the leaves of plants heavily infected with Stewarts leaf blight.

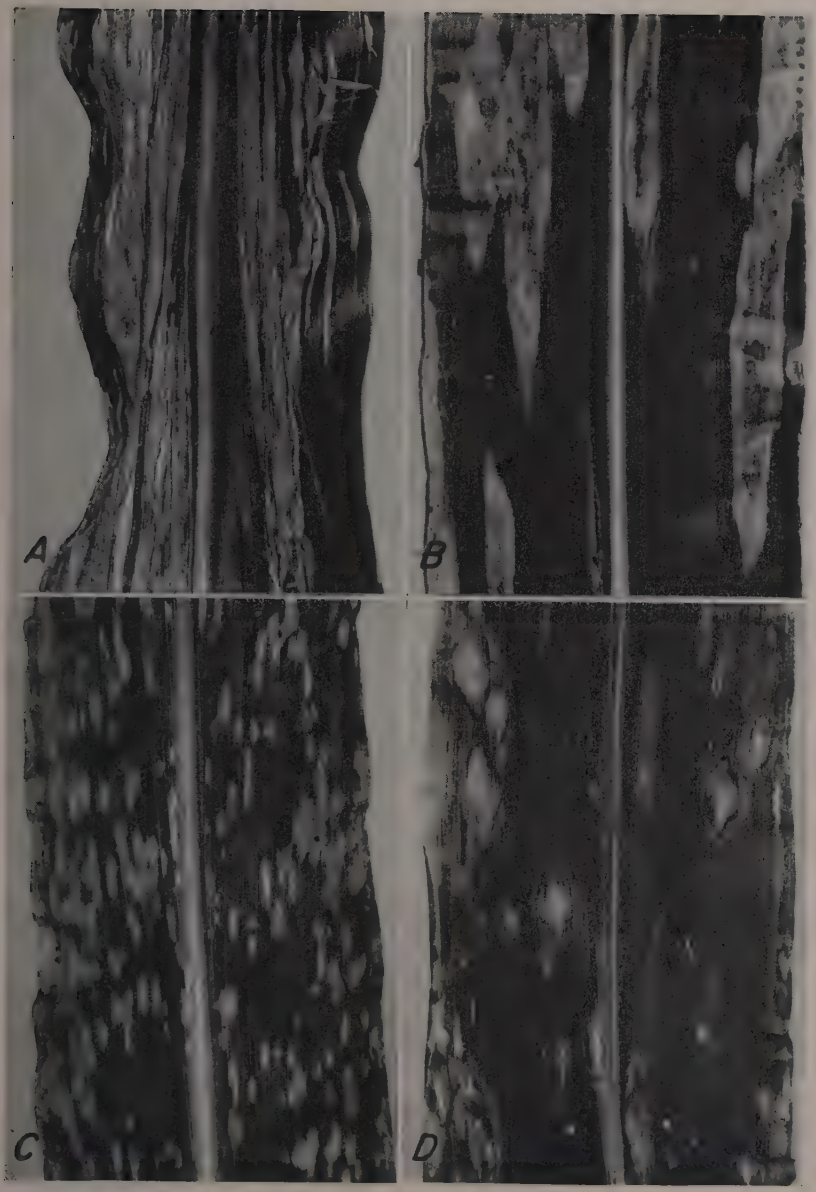


Figure 8.—Other leaf blights of corn that are different from Stewarts leaf blight: *A*, Bacterial leaf blight; *B*, northern corn leaf blight; *C*, southern corn leaf blight; and *D*, corn leaf spot.

corn. Infection may spread rapidly from such feeding areas.

It is probable that bacteria can live in seed for several months. Infected seed, therefore, may introduce the disease into uninfested regions or countries. However, only about 2 percent of the plants develop bacterial wilt when infected kernels are planted, thus infected seed cannot account for the heavy disease attacks that sometimes occur early in the season.

The bacteria occasionally may overwinter in soil, manure, or cornstalks, but it has not been demonstrated that plants become infected from these sources.

Relation of Disease Development to Winter Temperatures

There is a close relationship between the amount of bacterial wilt and of Stewarts leaf blight that develop in the Central and Northeastern States and the temperatures of the previous winter. A heavy epidemic of bacterial wilt on sweet corn is not likely to follow when the average temperature for the three winter months, December, January, and February, totals less than 100° F. Dent corn usually escapes severe attacks of Stewarts leaf blight when this total average temperature is not more than 85°. In the Northern States, the diseases may be wiped out by one severe winter. Farther South, however, where the winters are less severe, a series of cold winters apparently is necessary to cause decided decreases. Several successive mild winters tend to build up bacterial wilt and Stewarts leaf blight to epidemic proportions. Thus, a heavy epidemic of bacterial wilt occurred in the Central and Northeastern States in 1932 and 1933. Winter temperatures during 1930–31, 1931–32, and 1932–33 were 2° to 10° above normal throughout the Corn Belt and the Northeastern States. The winter of 1932–33 was particularly mild in New England.

The month of February 1934 was very cold, with temperatures 2° to 12° F. below normal in the eastern part of the United States, and wilt was reduced the following summer in most regions. In Virginia, however, wilt still was abundant in 1934 even after the cold winter of 1933–34, but by 1936 there was little infection because of unusually cold weather during the previous 3 winters. Later in the season, however, Stewarts leaf blight became general as new broods of flea beetles developed.

New York, New Jersey, and Pennsylvania reported more wilt and Stewarts leaf blight in 1947 than in several previous years. The winter temperatures in 1946–47 had been higher than usual. A similar situation occurred in Indiana and Ohio, especially with reference to Stewarts leaf blight.

Each year from 1949–54 forecasts of the severity of bacterial wilt and Stewarts leaf blight have been made in Illinois. These have shown that following mild winters in that State heavier attacks of bacterial wilt and Stewarts leaf blight occur.

In the States along the gulf coast the winters are always mild, yet bacterial wilt and Stewarts leaf blight occur only sporadically. These diseases are not problems in growing corn in this area.

Spread of the Diseases During the Corn-Growing Season

The first young corn plants to become infected with bacterial wilt are those attacked by overwintered corn flea beetles carrying the bacteria within their bodies. Other corn flea beetles not carrying the bacteria feed on the infected plants. Then they get the bacteria into their bodies and carry them to other corn plants on which they feed. New broods increase the number of beetles. Thus the disease becomes more general in a locality as the season

advances. The beetles may migrate or be carried by air currents considerable distances to start infections in other fields.

The beetles may carry and transmit the bacteria as long as they live. Thus, they carry them to dent corn late in the summer to start Stewarts leaf blight. Although only about 10 to 20 percent of the beetles coming out of hibernation in the spring carry the bacteria, up to 75 percent of the beetles feeding on corn in midsummer may be carriers. Heavy leaf infections appear on dent corn at this time or soon thereafter.

Control of the Diseases

The growing of resistant hybrids or varieties is the only practicable method of controlling bacterial wilt. Many resistant hybrids are available. Since the wilt bacteria may remain alive inside the seed from one season to another, they are not destroyed by surface treatment of the seed. Dry-heat treatments have been tried, but these cannot be recommended as yet. Transmission through the seed is responsible for so small a part of the field infections in the spring that it is of no practical importance. Seed treatments do not protect the plants from infection through feeding injuries of corn flea beetles, which is the source of most of the field infections.

The use of disease-free seed from sections where bacterial wilt does not occur also is no insurance against wilt. On the contrary, plants grown from seed produced in Maine, where bacterial wilt seldom occurs, were known in one year to be more susceptible to this disease than plants of the same variety grown from seed produced in Maryland, where wilt is prevalent.

There are no specific hybrids of dent corn that are known to be completely resistant to Stewarts leaf blight. It has been noticed that some of those that are resistant to northern corn leaf blight are also somewhat resistant to Stewarts leaf blight.

At present no practicable control measures for the corn flea beetles are known, but experimental tests show that spraying young corn with DDT wettable dust reduces the number of early-generation flea beetles and lessens the seriousness of the infection or delays its development.

Varietal Resistance to Bacterial Wilt

Some varieties and hybrids of sweet corn are resistant to bacterial wilt (fig. 9). Early-maturing varieties of all types of corn generally are more susceptible to bacterial wilt than are late varieties. Early yellow varieties of sweet corn, including Golden Bantam, Extra Early Bantam, Golden Early Market, and Improved Golden Bantam, were favorites up to the early 1930's, because of their quick maturity and high quality. They were susceptible to bacterial wilt, however, and for the canning trade were first replaced by later maturing, more resistant white varieties, such as Stowell Evergreen, Vanguard, and Country Gentleman.

Soon thereafter, new yellow sweet corn hybrids that were resistant to bacterial wilt began to replace the less desirable white sweet corn varieties in the canning industry. These hybrids, such as Golden Cross Bantam, Tendergold, Spancross, Whipcross, and Marcross, were comparatively free from wilt infection even when the more susceptible varieties were badly injured. Golden Cross Bantam, the first to be widely adapted, was released in the Corn Belt during the serious wilt epidemics of 1932 and 1933. Its success in the canning industry and the local market (fig. 10) greatly stimulated the development of other wilt-

Figure 9.—Rows of sweet corn showing varieties susceptible (left) and resistant (right) to bacterial wilt.

resistant hybrids. Spancross, Sencross, and Whipcross were among the first early resistant hybrids released in the Northeastern States. Two of those released in the Middle West were Indigold and Purgold, but these were too late in maturity to be entirely satisfactory. With the use of wilt-resistant hybrids came the gradual elimination of open-pollinated susceptible corn, and losses to growers even in years of wilt epidemics were greatly reduced. Further development of early-maturing resistant yellow hybrids was so successful that a serious threat of damaging bacterial wilt epidemics no longer existed by 1954.

Some of the common early, medium, and late resistant varieties used in 1954 are Marcross, Golden Jewel, Gold Rush, Seneca Arrow, Hoosier Gold, Seneca Chief, Iogold, Ioana, Seneca Market, Golden Cross Bantam, Golden Harvest, Golden Security, Calumet, Erie, Tendermost, Huron, Victory Gold-

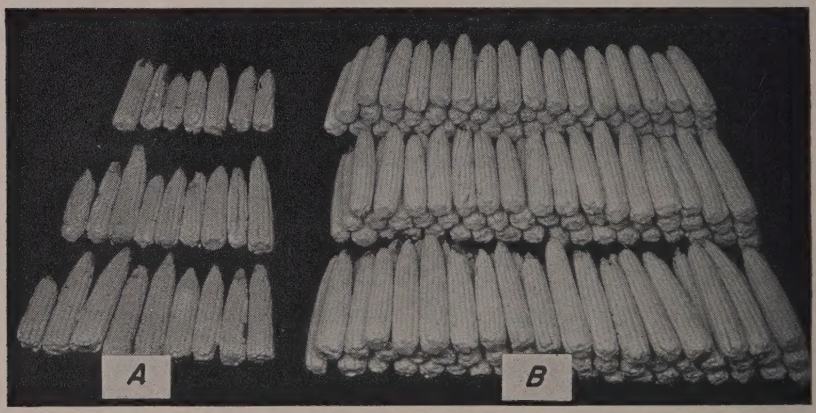


Figure 10.—Market ears of susceptible and resistant sweet corn grown in adjacent plots of the same size: *A*, Wilt-susceptible Golden Bantam; *B*, wilt-resistant Golden Cross Bantam.

en, Aristogold Bantam Evergreen, Illinois 10, and Iochief.[6]

Practically all white sweet corn hybrids containing lines of Country Gentleman and Stowell Evergreen are resistant to bacterial wilt. These include Country Gentleman (Ill.) No. 13, Country Gentleman (Ill.) 8×6, and Narrow Grain (Ill.) 14×11.

Early varieties of flour and flint corns are susceptible to bacterial wilt, but since they are grown only sparingly the disease losses in these types of corn are not serious.

Some dent corn hybrids, particularly early ones, are susceptible to bacterial wilt. Most of the dent corn hybrids adapted in the Corn Belt and in other areas are resistant to general infection.

Popcorn varieties also show differences in susceptibility to bacterial wilt, although information on them is limited. Black Beauty, Tom Thumb, Bear Foot, and Japanese Hull-less have been reported to be very susceptible, and South American and Sunburst to be resistant.

[6] For areas and purposes for which these varieties are adapted, get in touch with your State experiment station or write for Farmers' Bulletin 2042, Commercial Growing of Sweet Corn, U. S. Department of Agriculture, Washington 25, D. C.

Varietal Resistance to Stewarts Leaf Blight

Inbred lines that make up hybrids of dent corn and hybrids themselves show differences in susceptibility and resistance to Stewarts leaf blight. Even though specific breeding for resistance to this disease has not been done and the hybrids now in use have not been tested under heavy epidemic conditions, some are known to show more resistance than others.

Some hybrids that have shown at least a moderate degree of resistance to Stewarts leaf blight and which are now successfully grown in various parts of the United States are: Ind. 252, Ind. 419, AES 702, Ohio C38, Ohio C54, AES 805, Ohio L41, Conn. 870, Kans. 1830, Ill. 200, Ill. 784, Ky. 203, U. S. 523W, Dixie 22, Dixie 33, Dixie 17, N. C. 27, Georgia 101, Dixie 11, Dixie 18, and Dixie 82.[7]

[7] For areas in which these hybrids are suitably adapted and for others that may be successfully grown, contact your State agricultural experiment station.

U. S. GOVERNMENT PRINTING OFFICE: 1955

PREVENT FARM FIRES

Fires kill more than 3,000 farm people each year, and cause painful injury to many thousands more.

In farm homes fire is the main cause of death and injury among younger people.

Each year fires destroy $133,000,000 worth of farm property.

Much of this loss and suffering can be avoided by taking precautions to prevent fires or by being prepared to control those that do get started. In making a fire-safety check on your own farm, keep in mind that the primary causes of farm fires are—

- Lightning
- Sparks on the roof
- Defective chimneys or heating systems
- Faulty electric wiring or appliances
- Careless smokers
- Careless use or storage of gasoline, kerosene, oily rags, and such
- Children playing with matches

Don't start any fire unless you know you can stop it.

Keep a fire extinguisher handy and make sure every member of the family knows how to use it.

For details, see U. S. Department of Agriculture Farmers' Bulletin No. 1643, Fire Safeguards for the Farm.

16—69859-1 GPO